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ABSTRACT

This publication provides the goals, concepts, objectives, and rationale for the six activity guides in this series of energy education materials. The organization of this series, as presented in this publication, centers around six goals which correspond to the activity guides. Under each goal are several concepts, which in turn, have several objectives. These concepts and goals are referenced above the activities included in the guides. The six goals are: (1) It is essential that each person know that there are many sources of energy; (2) It is essential that each person know that people are dependent upon energy; (3) It is essential that each person know that energy can be converted from one form to another; (4) It is essential that each person know how man's use of energy creates an impact on the environmental and economic systems; (5) It is essential that each person know that the earth's resources are limited; and (6) It is essential that each person know that new energy sources and more efficient systems, accompanied by different consumption practices, may alter the world energy dilemma. This conceptual outline may be of use to teachers, curriculum specialists, and researchers. (MR)

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ENERGY ACTIVITY GUIDE

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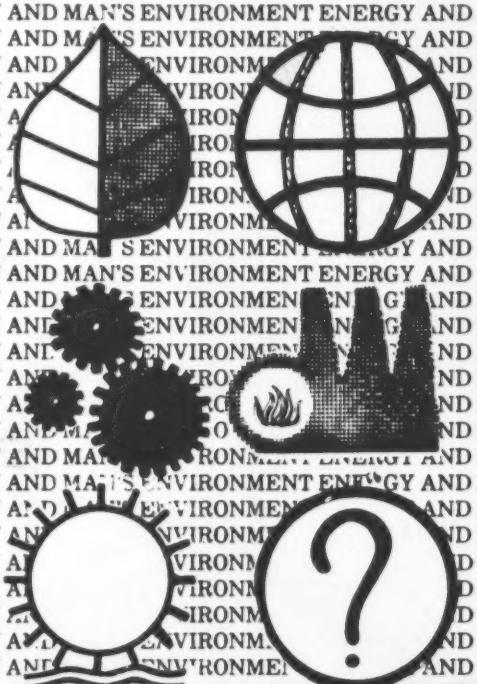

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ENERGY AND MAN'S ENVIRONMENT

Activity Guide

An Interdisciplinary Teacher's Guide to

Energy and Environmental Activities

Major Sections

- Sources of Energy
- Uses of Energy
- Conversion of Energy
- Impacts of Energy
- Limits of Energy
- Future Sources of Energy

John Jones, Editor

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Illustrations and graphics were prepared by Chloe Poole and Omer Gosnell.

COMMENT

Man stands at the end of a long cycle of energy exchanges in which there is a calculable and irreversible loss of energy at each exchange. A grown adult irradiates heat equivalent to that of a 75-watt bulb. His total energy output, in 12 hours of hard physical work, is equivalent to only 1-kilowatt hour. He requires daily 2200 calories of food intake, 4 1/2 pounds of water and 30 pounds of air, and he discards five pounds of waste. Considered as an energy converter, man is the least efficient link in his particular "food chain," and for this reason the most vulnerable to catastrophic ecologic change. Such a change can be caused by overloading the energy circuit. There are two new humans added to the globe's population every second.

Don Fabun, Dimensions of Change

WHY STUDY ENERGY?

BECAUSE WITHOUT ENERGY WE AREN'T! Energy, the ability to do work, is essential to all processes. In a real sense, energy performs the same function as the mainspring of a watch. Once wound, it provides the force which drives the mechanism. Energy is the mainspring which moves the dynamic elements of the living and non-living world.

Nature has concentrated some energy into useful forms such as wood, coal, oil and uranium. Our entire civilization has been erected upon this energy base. But times seem to be changing. Those who record, interpret and report trends have raised a warning flag. With nearly total unanimity, the scientific community indicates that our civilization is rapidly entering a period when energy will not be so abundant. Their message has tremendous implications for all of us -- you and me and, even more importantly, those who follow us and must live with the legacy of our decisions.

The period we are entering is characterized by a variety of interrelated factors. Predominant is population growth and the closely related acceleration of per capita consumption of natural resources. This latter factor is most relevant for us in North America where we consume far more than the rest of the world. We are less than 7% of the total global population. Our small minority consumes more than 50% of the entire annual world output of raw materials and over 35% of its energy. This imbalance will be increasingly difficult to maintain in light of the remainder of the world's aspiration for an improved standard of living and the concentration of 60% of the known world oil reserves in the Middle East.

The standard of living of a given country is related directly to its per capita gross national product and its per capita energy consumption. Data suggests that if a lesser developed country desires the standard of living of a developed country it must aspire to more energy-intensive activities. In a very real way energy and money are equivalent. To what degree the terms "standard-of-living" and "quality of life" are synonymous has been debated at length. However, it seems clear that future debates will take on increasingly practical dimensions.

It has been argued that the high standard of living of the U.S. is predicated on our history of collective scientific and technical ingenuity. But it can also be pointed out that the rapid industrial growth of the U.S. was made possible, in large part, by the discovery and exploitation of large reserves of high grade iron ore and coal in close proximity to one another, and the nearness of these resources to avenues of water transportation -- that is to say, fortunate geological coincidences. Coal provided energy to process the iron into the machines that gave us incredible mobility. Coal was abundant and cheap, as was oil. Oil fueled and lubricated our railroads, trucks and automobiles. Energy was so cheap we squandered it without much thought to its non-renewable nature. We have forgotten that non-renewable resources eventually become physically or economically impractical and must be replaced by a new resource. Characteristically, the high grade resources are used first because they are more available and cheaper to process; thus leaving the more inaccessible and more expensive resources for later exploitation. Obviously it requires increasingly larger quantities of energy to process lower grade ores. Because the traditional forms of energy are non-renewable resources the problem is compounded. Considered with population growth and the dramatic increase of resource consumption characteristic

of the 1950's, 60's and early 70's, the demands on non-renewable resources become untenable. The world is not in danger of being depleted of resources in the immediate future; more accurately, the question centers on our ability to cope with the pressures of change and redistribution.

In the mid 1970's we entered a period of hydrocarbon scarcity which began to dampen economic growth in the industrialized nations. This coming of hydrocarbon scarcity is in part a result of the oil producing nations desire for a fair share of the benefits of their resources. We in the technologically advanced and energy intensive nations must begin to make trade-offs that will markedly influence the future world society. It is unlikely that we can continue to use huge quantities of natural resources without an understanding of both the short and long-range economic, geopolitical and environmental consequences of our actions. It has been said, *"To err is human but when the eraser wears out before the pencil we're overdoing it."*

We must learn how everything we do both individually and collectively is related to energy. We must come to consider every resource as a valuable asset to be expended wisely. Educators have a principle role in achieving this critical task. Perhaps the message was most clearly stated by the wise person who observed:

Everything must *come from somewhere* (there is no such thing as a free lunch).

Everything must *go somewhere* (there is no "away").

Everything is connected to everything else.

WHO SHOULD USE THE ACTIVITY GUIDE

The Energy & Man's Environment Activity Guide is designed for everyone involved in making educational sense out of the complex energy situation. It is especially appropriate for classroom teachers, curriculum writers, and other persons engaged in the preparation of learning experiences that relate to energy and the environment.

WHY AN ACTIVITY GUIDE

The first edition of the Activity Guide was produced amid the concern and confusion of the petroleum curtailment by Middle East oil producing nations. It filled an urgent need for energy and energy-related ideas that could be immediately used in the classroom. During the subsequent two years more than 20,000 Activity Guides have been distributed to educators throughout the nation.

Although many of the immediate irritations of the oil embargo are gone -- long gas lines, limited availability of petroleum-based commodities, etc. -- the serious and more permanent consequences remain. We now have a dilemma; one described in terms of a re-distribution of the world's wealth, exponential population growth, and a growing acknowledgement of the finiteness of the world's resources. The continuing danger is clearly evident in the fact that since becoming aware nationally of the energy problem the United States has actually increased its dependence on the importation of foreign oil; has not developed a national energy policy; and has not made a significant investment in the development of new technology. The United States is vulnerable! We are vulnerable!

Only the community of educators appears to have the organizational and intellectual resources to prepare our youngsters to deal knowledgeable and effectively with the delicate energy and energy-related environmental questions they will be asked to resolve. This new Activity Guide and its accompanying resources are designed to make this vital task an easier and more productive one.

HOW THE ACTIVITY GUIDE MAY BE USED

The Activity Guide is a resource document with a wide variety of uses. A brief examination will reveal that it contains an organized listing of several hundred energy and environmentally related instructional ideas and activities. Each can be developed into a productive learning experience by a skillful teacher or curriculum worker. Use of the Activity Guide, therefore, depends largely upon the resourcefulness of the individual teacher and his or her knowledge and understanding of student needs.

There are several specific ways in which educators have productively used the Activity Guide: It has been used as an idea bank from which individual teachers have extracted single innovative ideas for the occasional introduction of energy concepts into lessons or units of study. It has served as a resource document for planning energy units. And it has been a useful tool for stimulating discussion in professional inservice programs.

Those who prepared the Activity Guide hope you will find it useful in your own effort to help youngsters become energy literate. Please let us know how you use the Guide and share with us the ideas you and your colleagues would like us to add to the

fund of ideas. A notation page has been included for this purpose.

THE POINT OF VIEW

As an organization, Energy and Man's Environment has no single point-of-view to express, and advocates no particular position concerning questions or issues of technology or environment. In keeping with traditions of academic integrity, E. M. E. seeks to encourage and support, in both its teacher training and curriculum development programs, an open forum for the presentation and discussion of ideas of every kind. However, if pressed, we would emphatically admit to encouraging balance and objectivity and to seeking energy and environmental literacy. We hope that this point-of-view is clearly reflected in the Activity Guide and that our effort will assist in some small way to increase the probability for the wise and efficient use of all resources.

ACTIVITY GUIDE ORGANIZATION

The Energy & Man's Environment Activity Guide contains six major sections. The sections are: **1. Sources of Energy, 2. Uses of Energy, 3. Conversion of Energy 4. Impacts of Energy, 5. Limits of Energy, and 6. Future Sources of Energy.**

Each section contains a number of concepts which, in the view of the E. M. E. staff, are necessary to a fundamental understanding of the general topic area. Conversely, when one has an understanding of the concepts related to a specific topic, he or she will have gained a basic grasp of the topic.

Listed under each concept are several simply stated ideas or activities. These are multidisciplinary in nature and vary in their complexity. Each list of ideas or activities is intended to suggest possible alternatives for achieving the concept under

which they are organized. Each must, of course, be developed into a viable learning experience by the teacher or curriculum maker.

OTHER E.M.E. INSTRUCTIONAL RESOURCES

Energy & Man's Environment has designed several interrelated energy and energy-related environmental education resources. These teaching and resource documents include:

1.* Activity Guide
2. Learning Activity Packages
3. Energy Blue Book (readings)
4. Energy-Environment Glossary
5. Energy Information Index
6. Energy Data Brief System
7. Energy Calendars

Each resource is designed to serve a specific educational purpose. Combined, they provide an interrelated and mutually supporting collection of valuable tools which will enable the teacher or curriculum worker to easily introduce energy concepts into the program of studies.

CONCEPTS AND OBJECTIVES

A review of the conceptual outline and supporting objectives for each of the six major sections of the activity guide will prove useful to all users of this document. This overview will provide a framework within which all energy related activities may be placed. Students and teachers who come to understand these concepts and objectives will join the ranks of a select few of the world's population who are energy literate.

SOURCES OF ENERGY

GOAL: **It is essential that each person know that there are many sources of energy.**

CONCEPT: I. Energy is the capacity to do work and is subject to natural laws.

OBJECTIVE:

A. The student will understand that energy is the capacity to do work and is subject to natural laws.

B. The student will be able to explain the meaning of "work."

C. The student will recognize that energy units measure the ability to do work.

D. The student will be familiar with the difference between kinetic and potential energy.

CONCEPT: II. Most specific forms of energy originated with the sun.

OBJECTIVE:

A. The student will understand the physical arrangement of the solar system.

B. The student should be familiar with the laws of gravitational attraction that keep the planets orbiting the sun and moves the tides on earth.

C. The student will understand that the sun's radiation produces surface and atmospheric heat.

D. The student will explain how the sun contributes to earth's life forms.

E. The student will understand that adoration of the sun's energy has contributed to the development of the religions of the world.

F. The student will know that the sun's energy can be stored for later use.

G. The student will understand that the sun can be used directly by humans.

CONCEPT: III. Natural processes are constantly forming and concentrating fossil fuels, but at a rate much slower than these sources are being used.

OBJECTIVE:

A. The student will understand the biological, chemical and geologic method of formation of each fossil fuel - coal, oil, gas and peat.

B. The student will understand the slow rate of formation of fossil fuels and the rate at which these fuels are being used today.

C. The student will understand the geologic origin of non-fossil fuel energy sources in the earth such as radioactive minerals.

CONCEPT: IV. Energy resources are unevenly distributed around the earth.

OBJECTIVE:

A. The student will understand why there is high heat flow in some areas but not in others, thereby affecting geothermal energy potential.

B. The student will understand that some geographic locations of wind, riverine, tidal and solar electric power plants are better than other locations.

C. The student will know the current locations of present and possible future fossil fuels.

D. The student will understand that nations with abundant resources have advantages over those who must purchase their energy resources from others.

CONCEPT: V. High grade (concentrated) energy sources occur in relatively small amounts, and take relatively smaller amounts of "outside" energy to find and recover.

OBJECTIVE:

A. The student will understand the concept of high grade for each form of energy.

B. The student will know energy costs for production of various fuels.

C. The student will know the approximate quantities of high, medium and low grade resources that are available to man.

D. The student will understand the difference between exploration (finding) and exploitation (producing).

E. The student will know that new technologies will be used to mine or recover energy sources.

CONCEPT: VI. Access to energy sources affects the growth of differing technological, social, governmental, economic and cultural systems.

OBJECTIVE:

A. The student will know the dominate energy sources for various cultures, past and present.

B. The student will know the flow of energy sources between countries in modern times and how it is likely to change.

C. The student will know that the location of cities and industries is often primarily influenced by access to energy sources.

D. The student will be aware of the influence of changing access to energy sources on the patterns of cultural development.

CONCEPT: VII. Exploitation of different energy sources results in a variety of occupations.

OBJECTIVE:

A. The student will explore the variety of occupations available in energy related industries.

USES OF ENERGY

GOAL: **It is essential that each person know that people are dependent upon energy.**

CONCEPT: I. All living things and natural processes require energy.

OBJECTIVE:

A. The student will simulate a food chain or food web.

B. The student will know that energy is necessary for growth.

C. The student will understand that all non-living natural processes require the input of energy.

D. The student will understand how and why living things store energy.

E. The student will understand how different organisms get their energy.

CONCEPT: II. Each form of energy can be used in many ways.

OBJECTIVE:

A. The student will understand that fossil fuels and other natural resources have both energy and non-energy applications.

B. The student will understand ways in which different energy sources may be used.

C. The student will understand that some energy resources and applications may be used in ways that are more aesthetically pleasing than others.

D. The student will know how energy is used at home, at school, and in the broader community.

E. The student will understand how engines use energy.

F. The student will understand that energy use follows a path from source to ultimate destination.

CONCEPT: III. All industrial processes make use of several forms of energy.

OBJECTIVE:

A. The student will understand that some forms of energy are more efficient and more applicable to certain uses than are others.

CONCEPT: IV. Some human technologies and activities use more energy than others.

OBJECTIVE:

A. The student will understand that different amounts of energy are used in the production of everyday items in the environment.

B. The student will understand why some technologies use more energy than do others.

C. The student will understand that availability of ample energy resources has produced high energy use technologies.

D. The student will learn that decisions to allocate future energy resources and to build future technologies may be based upon economic, aesthetic, political and social judgments.

E. The student will know and work with the basic units of energy measure.

F. The student will understand how man has used energy throughout history.

CONCEPT: V. Every decision made involving energy affects standards of living.

OBJECTIVE:

A. The student will understand the concept of a high standard of living.

B. The student will understand the relationship between standard of living and energy use.

C. The student will know which of the world's countries fall into the have and have nots and how/why the categorizations have changed over time.

D. The student will know the advantages which the people of a high standard of living country have over the people of a low standard of living country and the role that energy plays in contributing to the inequality.

E. The student will know energy choices man might make which would have trade-offs involved and be able to defend the choice on the basis of the trade-off created.

F. The student will know how social pressures to have things and use energy are created.

G. The student will know that planned obsolescence exists and is not in the best interest of society.

H. The student will know the concept of affluence and understand that its definition is peculiar to a given culture at a given time.

I. The student will know the various percentages of total energy use that each energy source provides and how those percentages have changed over time.

CONCEPT: VI. Social, economic and political pressures influence the efficient and economical use of energy.

OBJECTIVE:

A. The student will understand that governments establish regulatory controls which are designed to control energy use and pollution.

B. The student will realize that individuals may band together in citizen groups to effect political/social/economic choice.

C. The student will understand economic, political and social pressures which have been used to encourage the efficient and economical use of energy.

D. The student will understand that various governments have passed legislation which has affected the development and conservation of energy resources.

E. The student will understand that power balance shifts among countries often hinge on energy issues and concerns.

CONCEPT: VII. There are many ways to conserve energy.

OBJECTIVE:

A. The student will know numerous ways by which energy may be conserved at home, at school, and in the broader community.

B. The student will understand that some energy conservation practices may be more economical than others.

C. The student will know alternate strategies which may be employed by industry to conserve energy.

D. The student will note that industries and governments develop alternative strategies through a process of research and development.

CONVERSION OF ENERGY

GOAL: **It is essential that each person know that energy can be converted from one form to another.**

CONCEPT: I. There are natural and man-made energy conversion systems subject to natural laws.

OBJECTIVE:

A. The student will be able to identify the relationship between the first and second laws of thermodynamics and conversions.

B. The student will be able to define a "natural energy conversion system."

C. The student will be able to define man-made conversion systems.

D. The student will compare the efficiency of natural and man-made energy conversion systems.

E. The student will identify several man-made types of energy conversion.

F. The student will support the statement that "The waste products from a man-made energy conversion system are more difficult for the natural environment to accommodate than waste from natural energy conversion systems."

CONCEPT: II. All conversion processes use energy or lose heat energy.

OBJECTIVE:

A. The student will describe the transfer of energy in living systems.

B. The student will be aware that no conversion process is completely efficient. The price of conversion from a less usable to a more usable form is always waste heat. (e.g., chemical energy in oil to mechanical energy in an engine).

C. The student will be able to list the ways energy is used to exploit various energy sources.

D. The student should be able to identify by-products resulting from energy conversion.

CONCEPT: III. "Direct" energy use is more efficient than converted energy use but converted energy is more versatile.

OBJECTIVE:

A. The student will be able to describe the earth's heat budget.

B. The student will be able to determine the major factors which limit amount of solar energy reaching and being reflected from the earth.

C. The student will be able to identify examples of "direct energy" uses.

D. The student will be able to describe examples of indirect energy conversion situations that work for man.

CONCEPT: IV. There is a variety of units of measure for the efficiency of energy conversion.

OBJECTIVE:

A. The student will compare the energy output of a conversion system to the energy content of the energy source and note the unit of measure for each.

B. The student will identify at least seven units of measure to be used in comparing energy sources and the results of conversion.

CONCEPT: V. Energy "costs" are partly related to the efficiency of energy conversions and transport.

OBJECTIVE:

A. The student will explain why electricity costs less to produce from some sources than from others.

B. The student will compare published efficiencies of conversion costs of conventional nuclear and fossil steam electric plants with proposed magnetohydrodynamics system.

C. The student will be able to evaluate the costs related to the efficiency of different energy conversions.

D. The student will be able to compare the conversion costs of energy forms to their competitive economic relationship.

E. The student will identify reasons why energy costs more at the point of delivery to the customer than it did at the point of origin.

CONCEPT: VI. There are ethical, legal, aesthetic, social, political, economic, biological and physical benefits and problems associated with energy conversion.

OBJECTIVE:

A. The student will describe the legal, physical and aesthetic problems resulting from the construction of energy conversion plants.

B. The student will describe the physical reasons for the conversion of energy.

C. The student will identify some of the biological problems arising from the conversion of energy.

D. The student will identify ways that energy conversions by utilities benefit a community.

E. The student will be aware that there are problems arising from the disposal of energy conversion wastes.

CONCEPT: VII. Energy conversion technology has created technological and industrial changes.

OBJECTIVE:

A. The student will identify several pre-industrial societies which made little or limited use of energy conversions.

B. The student will be able to relate energy conversion technologies to standard of living.

C. The student will be able to describe how transportation has been affected by energy conversion.

D. The student will be able to identify the ways an industrial society makes use of energy conversion.

E. The student will be able to relate technological advances in energy conversion with society's industrialization.

CONCEPT: VIII. History can be described in terms of the level of energy conversion technology.

OBJECTIVE:

A. The student will be able to describe the major types of energy conversion used by early man.

B. The student will identify civilizations which used only conversions related to wind, fire, falling water and muscle power.

C. The student should be aware of the use of the energy source, coal, that led to the industrial revolution.

D. The student will explain the chronological patterns evident in the discovery and utilization of fuel conversion processes.

CONCEPT: IX. Employment opportunities are created or destroyed in the evolution of conversion technologies.

OBJECTIVE:

A. The student will be able to compare the jobs created and the jobs replaced by the advent of oil conversion.

B. The student will be able to describe those jobs resulting from the creating of electrical power and those replaced by this activity.

C. The student will be able to identify those job opportunities which were created and those which were reduced when coal displaced wood as a major energy source.

D. The student will describe career opportunities which have occurred as a result of nuclear power development.

E. The student will be able to list jobs which will be created as man converts the sun's energy to industrial uses.

IMPACTS OF ENERGY

GOAL: **It is essential that each person know how man's use of energy creates an impact on the environmental and economic systems.**

CONCEPT: I. Energy extraction and use alters original environmental conditions.

OBJECTIVE:

A. The student will know that gasoline fueled combustion engines endanger air quality.

B. The student will know that energy production plants affect environmental conditions.

C. The student will know that sewage treatment plants improve environmental conditions.

D. The student will know that petroleum and its derivitives degrade water environments.

E. The student will know that all air varies in the quantity of pollutants it carries.

F. The student will know all humans are polluters.

G. The student will know that energy extraction impacts the environment.

H. The student will know that intensity of energy use produces sociologic changes within and among human population groups.

CONCEPT: II. The use or non-use of any energy source requires environmental trade-offs.

OBJECTIVE:

A. The student will understand that the only lasting solution to declining energy resources is a world population decline.

B. The student will understand that any change in present energy use will affect employment patterns.

C. The student will understand that industrial and automobile emissions damage man-made and natural structures.

D. The student will understand that the site selection and design of industrial plants which use power involve environmental trade-offs.

E. The student will know that different energy users advocate different environmental trade-offs.

F. The student will know that different nations advocate different environmental trade-offs.

G. The student will know that the movement of people and goods requires environmental trade-offs.

H. The student will understand that the decisions people are willing to make about environmental trade-offs are based on internalized values.

CONCEPT: III. Various energy sources have differing impacts on the environment.

OBJECTIVE:

A. The student will understand that various energy sources and uses have differing impacts on the environment.

B. The student will understand that transportation and transmission of energy have an environmental impact.

C. The student will understand that different energy activity produces heat in differing amounts.

D. The student will understand that land use differs as energy use differs.

E. The student will understand that a marine environment reacts differently to oil activity than does a land environment.

CONCEPT: IV. Conflicts over ecologically sound practices and aesthetic judgments will involve trade-offs if they are to be resolved.

OBJECTIVE:

A. The student will understand that conflicts over ecologically sound practices and aesthetic judgments can be resolved.

B. The student will understand that some of these conflicts can be resolved by empirical processes.

C. The student will understand that some of the conflicts can be resolved by legal process.

D. The student will understand that some conflicts can be resolved by design processes.

E. The student will understand that some of the conflicts can be resolved by technological recycling processes.

F. The student will understand that some of these conflicts can be resolved by aesthetic processes.

G. The student will understand that some of these conflicts can be resolved by media-communication and economic processes.

CONCEPT: V. Efforts to regulate energy producers and users require energy, economic allocation and political effort.

OBJECTIVE:

A. The student will know that pollution control standards are a matter of legislation and law.

B. The student will know that the construction and abandonment of structures involving energy use are of concern to citizens.

C. The student will know that disagreement exists regarding the ways to control auto emissions.

D. The student will know that people holding different values differ in their attitudes regarding the need for more or new technical processes.

E. The student will know that new processes and devices to reduce pollution require energy use.

F. The student will know that existing and planned legislation may help or hinder the development of any industrial response to energy needs.

G. The student will know that different types of human activity require substantially different amounts of energy.

CONCEPT: VI. Some uses of energy are more threatening to ecosystems than are others.

OBJECTIVE:

A. The student will understand that some sources of energy are less threatening to biotic ecosystems than are others.

B. The student will understand that some ways of producing, transforming, and using oil are less threatening to biotic ecosystems than are others.

C. The student will understand that some human decisions involving energy use are less threatening than others.

D. The student will understand that stable human populations are less threatening to biotic ecosystems than increasing populations.

CONCEPT: VII. The environmental and economic consequences of energy use require additional energy.

OBJECTIVE:

A. The student will understand that the side effects of energy use requires additional energy.

B. The student will understand that energy use creates energy side effects.

C. The student will understand that the use of petroleum for energy creates side effects; energy is required to correct these side effects.

D. The student will understand that human use of products requires additional expenditures of energy for environmental and waste disposal purposes.

CONCEPT: VIII. Industrial societies have a greater impact on the environment than do agrarian societies.

OBJECTIVE:

A. The student will understand that most living Americans are personally heavy polluters.

B. The student will understand that all human activity - personally and collectively - releases heat into the biosphere.

C. The student will understand that industrial and consumer activity produces pollutants.

D. The student will understand that pollutants harm living substance.

E. The student will understand that most nations/states desire greater energy use.

F. The student will understand that improved living conditions have resulted from extensive energy use.

G. The student will understand that people in industrialized nations disagree about which environmental impacts are acceptable.

CONCEPT: IX. Maintenance or improvement of environmental quality necessitates large capital investment and/or reduced energy demand.

OBJECTIVE:

A. The student will know that maintenance or improvement of environmental quality necessitates large amounts of capital investment or reduced demand for energy.

B. The student will understand that air pollutants create economic loss.

C. The student will know that some industrial processes can use their waste products profitably.

D. The student will understand that sewage treatment plants use complex and expensive technology to improve environmental conditions.

E. The student will know that disagreements exist concerning the environmental quality to be secured, the capital allocations involved and the acceptable reduced energy demand.

CONCEPT: X. New technologies and careers have resulted from the environmental impact of energy.

OBJECTIVE:

A. The student will know that new technologies and careers have resulted from energy production and use.

B. The student will understand that new technologies have replaced or joined old technologies as a result of energy production and use.

C. The student will know that new careers have resulted from energy production and use.

LIMITS OF ENERGY

GOAL: **It is essential that each person know that the earth's resources are limited.**

CONCEPT: I. All sources of energy are limited; most can be used only once.

OBJECTIVE:

A. The student will understand what is meant by "limited" as related to energy resources.

B. The student will understand the terms "recycle" and "reuse."

C. The student will determine what forms of energy can not be reused.

D. The student will be able to describe the difference between renewable and nonrenewable energy resources.

E. The student will be able to explain how renewability or nonrenewability affects energy availability.

F. The student will be able to discuss personal activities which would extend the availability of nonrenewable energy resources.

G. The student will understand the relationship of "life style" to "finite energy resources."

H. The student will identify natural systems and describe their components.

I. The student will describe ways that man has upset natural systems in his quest for energy.

J. The student will understand the flow of energy from source to consumer.

K. The student will determine the flow of man-influenced energy conversion products into and through a natural system.

L. The student will understand how natural systems accommodate products from man's use of energy.

M. The student will understand the limits on energy use caused by the ability of earth's natural systems to accommodate effluents.

CONCEPT: II. Some energy sources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.

OBJECTIVE:

A. Fossil fuels are replaced within the earth in minute amounts each year.

B. Wood is a resource which is renewed rapidly within a human lifetime.

C. Falling water is a renewable resource.

D. Moving air (wind) has been and is an energy source in many parts of the world.

CONCEPT: III. Limitations may be viewed as relative to changing energy demands.

OBJECTIVE:

A. The student will understand the effects upon energy availability of various political (social), economic or environmental systems.

CONCEPT: IV. Knowledge and technology help develop and extend past, present and future energy resources.

OBJECTIVE:

A. The student will know factors that limit the technological growth and development of new energy sources.

B. The student will know examples where more efficient utilization of available energy is limited by man's ignorance or by lack of demand.

C. The student will know how a nation has overcome limitations of energy supplies.

D. The student will understand how start-up time lag limits the availability of new energy sources.

CONCEPT: V. Economic factors limit energy development and use.

OBJECTIVE:

A. The student will understand why there are economic constraints on development of energy sources.

B. The student will understand the economic benefits which result from either the development of new energy sources or changes in present sources.

C. The student will understand how dependence upon one energy source, domestic or foreign, is more limiting than development of a wide variety of energy sources.

D. The student will understand how the flow of dollars spent on energy sources affects the limits on energy use, conservation and waste.

E. The student will know the cost of energy in various societies.

F. The student will understand the economic effects of uneven distribution of energy resources in the world.

G. The student will understand that it takes energy to make energy.

H. The student will understand the need to use non-energy resources in developing energy sources.

CONCEPT: VI. Population change directly influences energy use, availability and supply.

OBJECTIVE:

A. The student will understand the correlation between population change and energy consumption.

B. The student will know the relationship between the standard of living and the limited availability of energy.

C. The student will understand the impact of limited energy supplies on the individual.

CONCEPT: VII. Societal actions influence, extend or exhaust available energy resources.

OBJECTIVE:

A. The student will understand how people have an effect upon decisions about themselves.

B. The student will understand how various political decisions can influence use of energy resources.

C. The student will understand and demonstrate how various segments of our society limit energy resource use.

D. The student will describe instances of how decisions benefiting short-term aims affected long term energy resources.

CONCEPT: VIII. Future technologies may be limited by existing resources.

OBJECTIVE: A. Developing technologies depend on availability of particular materials or capacities.

CONCEPT: IX. Limits of energy sources result in the creation of some kinds of jobs and loss of others.

OBJECTIVE: A. Changes in technology which may be required due to energy limits may result in great job displacement.

FUTURE SOURCES OF ENERGY

GOAL: **It is essential that each person know that new energy sources and more efficient systems, accompanied by different consumption practices may alter the world energy dilemma.**

CONCEPT: I. New energy technology may be developed in the future.

OBJECTIVE:

A. The student will describe the technology that will be required to improve existing energy systems.

B. The student will identify the principle energy sources and systems that may be available to us in the future.

CONCEPT: II. Future energy technologies will be judged by their combined economic, social, political, technical and environmental impacts.

OBJECTIVE:

A. The student will describe aesthetically acceptable energy production and utilization methods.

B. The student will describe the ways the geographic location and geological makeup of a nation influences its energy utilization practices.

C. The student will identify the energy sources which will be available in diminishing quantities in the future.

D. The student will describe the characteristics of the "ideal" energy source.

E. The student will list energy policy decisions that are made representing various known energy sources in the U. S.

CONCEPT: III. Future energy technologies may provide abundant energy with which to modify the environment.

OBJECTIVE:

A. The student will describe the raw resources in the U. S. and the number of years each will last at the present rate of consumption.

B. The student will discuss the value of recycling materials as a method of extending natural mineral supplies.

CONCEPT: IV. Energy availability will affect future life styles and cultural conditions.

OBJECTIVE:

A. The student will describe the relationship between individual energy consumption and quality of life.

B. The student will describe personal liberties which may be affected by changes in future availability of energy.

C. The student will predict changes in land use planning priorities associated with the development of energy resources in the future.

D. The student will compare the life styles of a relatively energy independent household to one which depends largely upon centralized energy production facilities.

E. The student will describe the consequences of exhausting the world's fossil resources.

F. The student will identify ways of extending the life of the crude oil supply by reducing consumption.

G. The student will list the ways new energy sources use will affect future home and building design.

CONCEPT: V. Future energy systems will require large amounts of economic capital.

OBJECTIVE:

A. The student will identify reasons why some sources of energy are increasing in use while others are declining.

B. The student will demonstrate an understanding of basic energy economics.

CONCEPT: VI. Energy policy decisions will affect the availability and distribution of energy in the future.

OBJECTIVE:

A. The student will list energy utilization decisions over which the individual has considerable influence.

CONCEPT: VII. The availability of control of energy resources condition international relationships.

OBJECTIVE:

A. The student will describe the effect of new energy resources on a nation.

B. The student will describe some of the national and international environmental impacts of energy accessibility and usage.

C. The student will describe the characteristics of an energy insufficient nation in relationship to other nations.

D. The student will describe the characteristics of an energy self-sufficient nation in relationship to other nations.

CONCEPT: VIII. Future energy development will require new job skills.

OBJECTIVE:

A. The student will evaluate the effect on the job market of a shift toward a recycle society.

B. The student will describe jobs which would be created or eliminated in the event of new developments and technologies in energy.

C. The student will predict the kinds of jobs eliminated and jobs created with the advent of severely limited energy resources.

D. The student will identify new job skills which have recently become necessary as a result of emerging technologies.